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DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

PEBBLE-PHOSPHATE MINE ACCIDENT EXPERIENCE

BY

FRANK E. CASH AND CLAUD P. DEMPSEY

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DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

PEBBLE-PHOSPHATE MINE ACCIDENT EXPERIENCE[1]

By Frank E. Cash[2] and Claud P. Dempsey[3]

INTRODUCTION

The information in this report covers the accident experience of the pebble-phosphate industry of Florida for 1935 and 1936, as well as the 5 years 1930-34, inclusive, statistics of which were published in Information Circular 6917[4].

The compilation and publication of such accident experience statistics enable the pebble-phosphate industry, as well as other industries, to consider relative hazards and to compare experience and thereby promote accident prevention.

ACKNOWLEDGMENTS

Accident data were furnished by the following operating companies: Amalgamated Phosphate Co., Brewster; The American Agricultural Chemical Co., Pierce; Coronet Phosphate Co., Plant City; International Agricultural Corporation, Mulberry; The Phosphate Mining Co., Nichols; Southern Phosphate Corporation, Bartow; and Swift & Co., Fertilizer Works, Bartow. Production figures are from Mineral Resources of the United States and Mineral Yearbooks[5]. The descriptive matter was taken in part from a publication by Cash and von Bernewitz[6]. Acknowledgment is made of assistance received from the publications quoted and from the officials of the operating companies in making this report possible.

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6968."

2/ District engineer, U. S. Bureau of Mines Safety Station, Birmingham, Ala.

3/ Senior safety instructor, U. S. Bureau of Mines Safety Station, Jellico, Tenn.

4/ Cash, Frank E., and Dempsey, Claud P., Pebble-Phosphate Accident Experience: Inf. Circ. 6917, Bureau of Mines, 1936, 10 pp.

5/ Bureau of Mines, Mineral Resources of the United States, 1925-31 (prior to 1925, data assembled by the U. S. Geol. Survey); Minerals Yearbook, 1932-33-34 and 1935.

6/ Cash, F. E., and von Bernewitz, M.W., Methods, Costs, and Safety in Stripping and Mining Coal, Copper Ore, Iron Ore, Bauxite, and Pebble Phosphate: Bull. 298, Bureau of Mines, 1929, 275 pp.

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MINING DISTRICT

Most of the land pebble-phosphate district of Florida is in the western part of Polk County and the eastern part of Hillsborough County, but it extends south into the northwest corner of DeSota County and the northeast corner of Manatee County. The area now considered workable extends from near Plant City on the north almost to Bowling Green on the south - 30 miles in a northwest and a southeast direction and with an average width of 10 miles.

PRODUCTION

Florida produces approximately 85 percent of the phosphate mined in the United States and 95 percent of the Florida production.

Production of land-pebble phosphate in Florida was begun in 1890; the first shipment was made in 1891, and at present, under normal conditions, annual shipments amount to between two and three million long tons7/.

MINING METHODS

The phosphate conglomerate or matrix is overlain by 10 to 50 feet of sand, sandy clay, or porous, friable sandstone, which constitute the overburden. The overburden is removed either by traction, electric dragline excavators with 120- to 160-foot booms and 6- to 10-cubic-yard buckets, and "spoiled" in areas from which the matrix has been mined, or it is removed hydraulically.

The matrix, which is 5 to 20 feet thick, is mined by hydraulic "giants" or "guns" that have a nozzle pressure of 170 to 220 pounds per square inch. Before mining is begun, it is necessary to have a well, sump, or low place in which to accumulate the dislodged matrix picked up by the pumps. These wells or sumps are made by the excavator or by water pressure or are drill blasted. After the sump is prepared and the pump connected the bed of matrix is cut down by the hydraulic guns, flows into the sump, and is picked up by 10- and 12-inch centrifugal pumps driven electrically, handling 10 to 25 percent solids and using from 2,500 to 4,000 gallons of water. If the height or distance between sump and washer becomes too great, one or more relay or booster pumps is placed in the line between the pit and washer.

7/ See footnote 5.

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WASHING AND DRYING

The matrix is discharged into processing plants called washers, in which it is dewatered, processed to remove slimes and clay, and screened to remove the sand and small pebbles of phosphate. The rejected fines are reclaimed later by flotation, and the washed phosphate pebbles are loaded into cars and hauled by steam or electric locomotives to the drying plant. The rock is dried in oil-fired rotary kilns at an average temperature of 225° F. at the discharge end and conveyed by belts to classified storage bins, from which shipments are made.

FLORIDA WORKMEN'S COMPENSATION ACT

The Florida Workmen's Compensation Act, enacted by the 1935 Legislature, became effective July 1, 1935. The Act is administered by the Florida Industrial Commission, consisting of a chairman, appointed by the Governor, and two other members selected from the Governor's cabinet.

The total expense of administering the Act is prorated and borne by insurance companies writing compensation insurance in the State and by self-insurers.

All employers and employees, except a few specifically exempted, come under the act unless they file the required notice of nonacceptance and waiver of exemption; in which case, the employer may not, in suits brought against him, use as defense negligence of a fellow-servant, nor that the employee assumed the risk of his employment, nor that the injury was due to the contributory negligence of the employee; and the employee who refuses to come under the Act, in any action to recover damages for injury or death brought against an employer who accepts the provisions of the Act, may proceed as at common law; and the employer may avail himself of the defense of negligence of fellow-servant, assumption of risk, and contributory negligence, as such defense exists at common law.

Provisions are made for the employer to furnish medical, surgical, hospital, and nursing attention that may be required during the period of recovery. If death results from an accident, the employer must pay reasonable burial expenses, not exceeding $150.

Compensation is allowed for the first 14 days, unless the accident causes disability for more than 28 days, in which case compensation is allowed from the date of disability. The amount of compensation shall not exceed $18 per week nor be less than $4 per week, unless at the time of the injury the employee's wages are less than $4 per week, when he shall receive his full weekly wage. Payments of compensation are made on the following basis: 50 percent of the average weekly wage if there are no dependents, 55 percent if one dependent, and 60 percent if more than one dependent; payment is made for all temporary total disabilities and for the following periods in case of death or permanent disabilities: Death 350 weeks; permanent total disability 350 weeks; loss of arm 200 weeks; leg 175 weeks; hand 150 weeks; foot 125 weeks;

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eye 100 weeks; thumb 60 weeks; first finger 35 weeks; great toe 30 weeks; second finger 30 weeks; third finger 20 weeks; fourth finger 15 weeks; toe other than great toe 10 weeks; loss of hearing, one ear 40 weeks and two ears 150 weeks; loss of two hands, two arms, two feet, two legs, and two eyes constitutes permanent total disability.

The foregoing is abstracted from House Bill 29, as enacted by the 1935 Florida Legislature.

SAFETY ORGANIZATIONS

Every company in the pebble-phosphate district has a safety director and employees' safety organization that holds regular periodical meetings. Accidents and "near" accidents are discussed in these meetings, and suggestions are made for the prevention of future similar accidents; also, employees are encouraged to make suggestions for improving living and working conditions in and around the mines and plants.

One of the oldest and most active chapters of the Holmes Safety Association in the United States is functioning in one of these mining communities and all matters pertaining to safety are handled by the chapter.

All of the operating companies have some of their employees trained in first aid each year. Most of them maintain 100-percent first-aid training annually on a cooperative basis; in other words, all employees are trained annually by company instructors under the supervision of an instructor from the Safety Division of the United States Bureau of Mines. As a part of or climax to the training, annual first-aid contests are held; in 1936, six of the seven producing companies participated and performed before a large group of interested spectators.

ACCIDENT EXPERIENCE

Data were made available by all of the operating companies; to present them on a basis comparable with other industries (taking into consideration relative hazards), total days lost will be increased in some instances, as partial permanent disabilities are carried in the district as actual days lost and fatal accidents are charged by two companies without loss of time.

Partial and total permanent-disability and fatal-accident statistics uniformly comparable with those for other industries have been converted into their equivalent of days lost according to the Scale of Time Losses for Weighting Deaths and Permanent Injuries to Show Severity of Injuries, used by the United States Bureau of Mines. (See table 1.)

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TABLE 1. - Scale of time losses for weighting deaths and permanent injuries so as to show severity of injuries[1]

Nature of injury[2]	Degree of disability, in percent of permanent total disability	Days lost
Death	100	6,000
Permanent total disability	100	6,000
Arm above elbow, dismemberment or loss of use of	75	4,500
Arm at or below elbow, dismemberment or loss of use of	60	3,600
Hand, dismemberment or loss of use of	50	3,000
Thumb, dismemberment or loss of use of	10	600
Any one finger, dismemberment or loss of use of	5	300
Two fingers, dismemberment or loss of use of	12-1/2	750
Three fingers, dismemberment or loss of use of	20	1,200
Four fingers, dismemberment or loss of use of	30	1,800
Thumb and one finger, dismemberment or loss of use of	20	1,200
Thumb and two fingers, dismemberment or loss of use of	25	1,500
Thumb and three fingers, dismemberment or loss of use of	33-1/3	2,000
Thumb and four fingers, dismemberment or loss of use of	40	2,400
Leg above knee, dismemberment or loss of use of	75	4,500
Leg at or below knee, dismemberment or loss of use of	50	3,000
Foot, dismemberment or loss of use of	40	2,400
Great toe or any two or more toes, dismemberment or loss of use of	5	300
One toe, other than great toe, dismemberment or loss of use of	0	.....
One eye, loss of sight	30	1,800
Both eyes, loss of sight	100	6,000
One ear, loss of hearing	10	600
Both ears, loss of hearing	50	3,000

1/ Bureau of Mines, Rules Governing the Award of Trophies in the National Safety Competition for 1936, p. 3.
2/ Dismemberment means severance of any part of the bone.

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Tables 2 to 5, inclusive, contain accident figures for the phosphate companies by months, age of injured, and nature and cause of injuries; tables 6 and 7 consolidate these figures for the pebble-phosphate industry, and table 8 compares the pebble-phosphate accident experience with that of other industries.

Table 2 shows that there is relatively little difference in the number of accidents for any month of the year; the greatest number of lost-time accidents occurred in September and October and the smallest number in November and February during the 7-year period, although the greatest number occurred in January and the fewest in February for the period 1930-34, inclusive.

Accidents in the first three age groups are almost directly proportionate to the number employed, but in the last two groups accidents are less frequent in proportion to the men employed. This would indicate that experience makes pebble-phosphate employees safer workmen.

According to table 4, feet are hurt most frequently, with 79 lost-time accidents; fingers are next, with 74; back, third, with 56; and eyes, fourth, with 43.

There is no doubt but that the use of protective clothing, such as hard hats, gloves, safety shoes, and goggles, would reduce the number of accidents in the industry.

According to table 5, falls of persons cause 17.4 percent of the lost-time accidents, handling material 17.2 percent, machinery 12.2 percent, and falling material 9.1 percent.

It is realized that the method of mining, with particular reference to the amount of water used, tends to make the footing uncertain, but the probabilities are that better care of walkways around the pits and washing plants would reduce the number of accidents from falls of persons and handling material.

A lost-time accident is one that causes the loss of more than the shift or day on which the accident occurred.

The accident-severity rate indicates the number of calendar days of disability from accidents per thousand hours worked.

Accident-frequency rates indicate the number of fatal and nonfatal lost-time injuries per million man-hours worked.

During 1935, four of the companies lowered the accident-frequency rate as compared with that for 1930-34 and three increased it. In 1936, five had lower and three had higher frequency rates compared with 1930-1934. Five companies had lower and two had higher frequency rates for 1935 and 1936 than for 1930-1934. Six of the operating companies had lower severity rates and one had a slightly higher one during 1935 and 1936, whether the rates are taken separately for each year or are combined for the 2-year period.

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TABLE 2. - Accidents, by months, 1930-36

Month	Year	Company A	B	C	D 1/	E 2/	F	G	Total
January	1930-34	9	18	3	5	-	9	4	48
	1935	1	1	0	0	0	5	0	7
	1936	0	1	0	0	0	1	0	2
February	1930-34	2	7	4	4	-	5	1	23
	1935	0	0	0	1	1	5	0	7
	1936	2	2	0	0	1	4	0	9
March	1930-34	3	9	3	5	-	11	2	33
	1935	2	1	0	0	2	3	0	8
	1936	3	1	1	1	1	1	0	8
April	1930-34	4	13	2	2	-	9	2	32
	1935	0	0	2	1	1	3	1	8
	1936	0	0	0	1	0	1	0	2
May	1930-34	4	12	1	3	-	10	2	32
	1935	3	1	0	0	1	2	0	7
	1936	0	3	0	2	0	2	0	7
June	1930-34	1	8	4	2	-	10	1	26
	1935	2	1	1	0	0	7	0	11
	1936	0	3	0	1	0	3	0	7
July	1930-34	4	7	1	9	-	12	4	37
	1935	3	0	0	1	0	6	1	11
	1936	1	1	0	1	1	2	0	6
August	1930-34	2	4	2	3	-	11	6	28
	1935	0	0	0	1	2	4	0	7
	1936	4	1	1	0	1	0	0	7
September	1930-34	3	12	1	5	-	9	7	37
	1935	0	0	0	5	7	8	1	21
	1936	2	4	1	5	2	2	0	16
October	1930-34	2	8	3	3	-	10	4	30
	1935	3	1	0	0	4	8	0	16
	1936	6	0	2	4	0	4	1	17
November	1930-34	2	2	0	4	-	10	6	24
	1935	1	1	0	0	2	3	0	7
	1936	2	0	0	0	1	1	1	5
December	1930-34	2	11	4	3	-	10	1	31
	1935	0	3	0	0	2	3	1	9
	1936	0	0	0	0	3	3	0	6

1/ 1931-36
2/ 1935-36
5898

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TABLE 3. - Age of injured, 1930-36

Age	Company A	B	C	D[1]	E[2]	F	G	Total
18-28	22	39	9	17	9	26	13	135
28-38	24	44	8	25	8	22	19	150
38-48	24	34	14	16	6	19	12	125
48-58	3	17	4	16	7	13	1	61
58-68	0	2	1	1	2	1	1	8
Total	73	136	36	75	32	81	46	479

1/ 1931-36.
2/ 1935-36.

TABLE 4. - Parts of the body injured, 1930-36

Member	Company A	B	C	D[1]	E[2]	F	G	Total
Head	1	1	2	1	3	3	2	13
Face	1	6	-	4	3	2	2	18
Eyes	13	9	2	3/3	10	4	2	43
Shoulder	2	7	-	3	-	3	-	15
Arm	3	4	3	2	4	5	2	23
Wrist and hand	5	6	2	4	1	11	1	30
Fingers	3/12	20	4	3	14	14	4/7	74
Chest	2	9	3	4	2	5	2	27
Back	3	9	2	17	11	10	4	56
Pelvis	-	-	-	-	-	-	1	1
Groin	-	3	-	-	2	2	-	7
Hip	2	-	-	1	-	2	-	5
Thigh	2	-	-	-	1	-	-	3
Leg	6	8	2	5	6	6	1	34
Knee	2	6	3	-	1	2	4	18
Ankle	1	11	2	5	4	5	1	29
Foot	10	24	6	11	9	6	13	79
Toes	6	5	1	7	-	1	1	21
Internal	1	7	4	2	-	-	1	15
Infection	-	-	-	-	-	-	-	0
Heat	-	-	-	-	-	-	1	1
Fatal	1	1	-	-	1	-	1	4
Total	73	136	36	72	72	81	46	516

1/ 1931-36.
2/ 1935-36.
3/ One partial permanent.
4/ Two partial permanent.

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TABLE 5. - Classification of accident causes, 1930-36

Causes	Company							Total	Percent total
	A	B	C	D[1]	E[2]	F	G		
Handling material	12	0	8	23	11	21	14	89	17.2
Machinery	8	21	7	10	6	5	6	63	12.2
Falling persons	10	29	5	16	7	16	7	90	17.4
Hand tools	5	8	4	8	9	3	4	41	7.9
Falling material	5	27	1	1	2	9	2	47	9.1
Haulage	1	7	0	4	8	0	1	21	4.1
Nails, etc.	6	8	1	1	2	6	0	24	4.7
Burns	3	9	0	5	3	5	2	27	5.2
Electricity	1	7	0	1	2	1	3	15	2.9
Flying objects	9	3	5	0	4	6	0	27	5.2
Infections	0	0	4	1	1	1	2	9	1.8
Automotive equipment	7	0	0	1	4	1	0	13	2.5
Striking objects	2	0	0	0	0	6	1	9	1.8
Explosives	1	0	0	0	0	0	1	2	0.4
Miscellaneous	3	17	1	1	13	1	3	39	7.6
Total	73	136	36	72	72	81	46	516	100.0

1/ 1931-36.
2/ 1935-36.

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TABLE 6. - Operating companies accident experience, 1930-36

Company	Average no. of men	Man-hours of exposure	No. of lost-time accidents	Days lost	Frequency	Severity
A						
1930-34	245	2,335,944	38	6932	13.39	2.440
1935	230	269,028	15	141	55.76	0.524
1936	254	557,882	20	606	35.84	1.084
1935-36	242	826,910	35	747	42.32	.902
B						
1930-34	388	5,933,953	111	11374	18.71	1.930
1935	360	893,904	9	52	10.07	0.058
1936	235	769,575	16	188	20.74	0.244
1935-36	323	1,663,409	25	240	15.03	0.144
C						
1930-34	126	1,341,853	28	239	20.86	0.180
1935	108	241,036	3	40	12.44	0.166
1936	110	292,062	5	168	17.12	0.575
1935-36	109	533,098	8	208	16.01	0.390
D						
1930-34	240	1,671,604	48	2371	28.76	1.420
1935	252	673,872	9	39	13.35	0.057
1936	274	621,036	15	177	24.15	0.288
1935-36	263	1,294,908	24	216	18.53	0.167
E						
1930-34	65	745,142	40	6579	53.58	8.800
1935	163	373,759	22	331	58.82	0.885
1936	137	314,141	10	118	31.84	0.375
1935-36	150	687,900	32	449	46.52	0.638
F						
1930-34	193	2,563,040	116	7214	45.29	2.810
1935	150	641,813	57	591	88.84	0.928
1936	200	684,000	24	395	38.46	0.633
1935-36	175	1,265,813	81	986	63.98	0.778
G						
1930-34	295	3,903,861	40	7248	10.24	1.84
1935	330	770,131	4	40	5.19	0.052
1936	340	733,088	2	300	2.72	1.429
1935-36	335	1,503,219	6	340	3.99	0.226

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TABLE 7. - Pebble phosphate industry's accident experience, 1930-36

	1930	1931	1932	1933	1934	1935	1936	1930-34	1935-36	1930-36
Number of mines, washers, and plants	38	40	39	39	39	38	36	39	37	37
Production (long tons)	3,166,318	1,900,806	1,402,334	2,066,900	2,249,304	2,269,891	2,442,520	10,785,662	4,712,411	15,498,073
Average number of men	1,615	1,436	1,222	1,493	1,730	1,593	1,600	1,552	1,597	1,565
Man-hours of exposure	5,211,219	4,086,434	3,293,651	3,255,650	3,795,364	3,863,597	3,911,784	18,995,346	7,775,381	26,770,727
Number of lost-time accidents	101	103	48	80	89	119	92	421	211	632
Number of days lost-time	1,240	7,092	6,737	12,645	14,243	1,234	1,952	41,957	3,186	45,143
Frequency	19.38	24.96	14.27	24.26	23.45	30.79	23.51	22.05	27.13	23.61
Severity	0.240	1.740	2.050	3.890	3.760	0.319	0.499	2.210	0.409	1.686

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TABLE 8. - Accident-frequency and severity rates, 1930-36

Year	Frequency		Severity	
	All Industries[1]	Pebble Phosphate	All Industries[1]	Pebble Phosphate
1930	18.47	19.38	1.97	0.240
1931	15.12	24.96	1.72	1.740
1932	13.20	14.27	1.59	2.050
1933	14.56	24.26	1.59	3.890
1934	15.29	23.45	1.70	3.760
1935	14.02	30.79	1.58	0.319
1936	-	23.51	-	0.499

1/ All industries figures from Accident Facts, National Safety Council.

Although comparison with all industries does not place the pebble-phosphate industry in a leading position with regard to frequency and severity of accidents, its accident record is commendable when the relative hazards are considered.

CONCLUSIONS

The accident record of the pebble-phosphate industry as a whole is good; it has been worse and probably will be improved beyond its present status because the operating companies make safety or accident prevention an operating phase of paramount importance, and this is almost certain to produce good results in time.

Analysis of the causes of accidents to employees of the various companies at regular periodic safety meetings, better "job housekeeping," more general use of protective clothing, and continuous training or education of employees unquestionably will improve the already good accident record of the industry.

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